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WOODS HOLE OCEANOGRAPHIC INSTITUTION

Woods Hole, Massachusetts

Reference No. 51-87

SEA-SALT NUCLEI STUDIES

conducted during the period

July 1, 1951 - September 30, 1951

Periodic Status Report No. 2
Under Contract N6onr-27711 (NR-085-001)
With Office of Naval Research

October 1951

APPROVED FOR DISTRIBUTION _____

Director

The Contractor shall furnish the necessary personnel and facilities for and, in accordance with any instructions issued by the Scientific Officer or his authorized representative, shall conduct research on the practical aspects of atmospheric sea-salt nuclei, which shall include, but not necessarily be limited to, the following:

(1) role of atmospheric sea-salt nuclei in the formation of rain with emphasis upon the relationship between weight and number of nuclei and the occurrence of rain;

(2) distribution of airborne sea-salt as a factor in the corrosion of structural steels, the primary investigation to determine how far inland sea-salt is carried by the winds, and the rates at which it is deposited on exposed structures; and

(3) determination of the water vapor pressures over concentrated sea water at lower temperature, and the study of super saturation of droplets of concentrated sea water.

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PART I

Airborne Salt Particles and Rainfall at Oahu, T. H.

At the American Meteorology Society meeting in New York in February 1951, Mr. A. H. Woodcock gave his paper "Atmospheric Salt Particles and Raindrops". Later Dr. Harry Wexler and Mr. Robert Simpson of the U. S. Weather Bureau together with Dr. Irving Langmuir of the General Electric Company, Schenectady, New York suggested that Mr. Woodcock make his next field study at Hawaii instead of returning to the Florida area. It was felt that the advantages at Hawaii exceeded those at Florida due to constancy of weather and detailed meteorological data routinely assembled by the pineapple and sugar cane industries.

As a result of this suggestion and at the invitation of the Pineapple Research Institute of Honolulu, Mr. Woodcock spent the month of June in Hawaii and the following report results from studies made at that time.

During the month of June 1951, a preliminary study of the day-to-day variation of the salt content in the atmosphere was made near the island of Oahu in the Territory of Hawaii. The primary purpose of these measurements was to learn something of the relationship between the occurrence of large numbers of salt particles in the clear air over the sea on the windward side of Oahu and the rainfall on the island as measured daily in 212 gages. The possibility that such a "relationship" might exist is implicit in the results reported by Woodcock in W. H. O. I. Technical Report No. 51-71. The above technical report also contains an account of the methods used for sampling atmospheric salt at Oahu.

Samples were taken on 12 days, at altitudes ranging from 300 to 7400 feet. In most cases however sampling was done about 200 feet below the base of local cumulus clouds and over the sea about 10 miles northeast of Mokapu Point on the northeast side of Oahu Island.

These samples show a wide range of variation in the number of the larger salt particles present in the air at nearly constant altitudes. Among particles weighing 380 $\mu\mu$ grams or more the number varied from 68 to 2900 per cubic meter of air during the 12 sampling days.

Figure 1 gives the distribution of the numbers of salt nuclei of various weights at several altitudes on June 4th. The 7500 foot level was above the trade-wind inversion,

ALTITUDE NO. PARTICLES

m^{-3} OF AIR

	FT.	1.5 $\mu\mu$ gms or greater
1 =	200	156,270
2 =	1840	455,960
3 =	4080	50,141
5 =	7500	8,414

WEIGHT OF SEA SALT IN PARTICLES ($\mu\mu$ GRAMS)

CUMULATIVE (%)
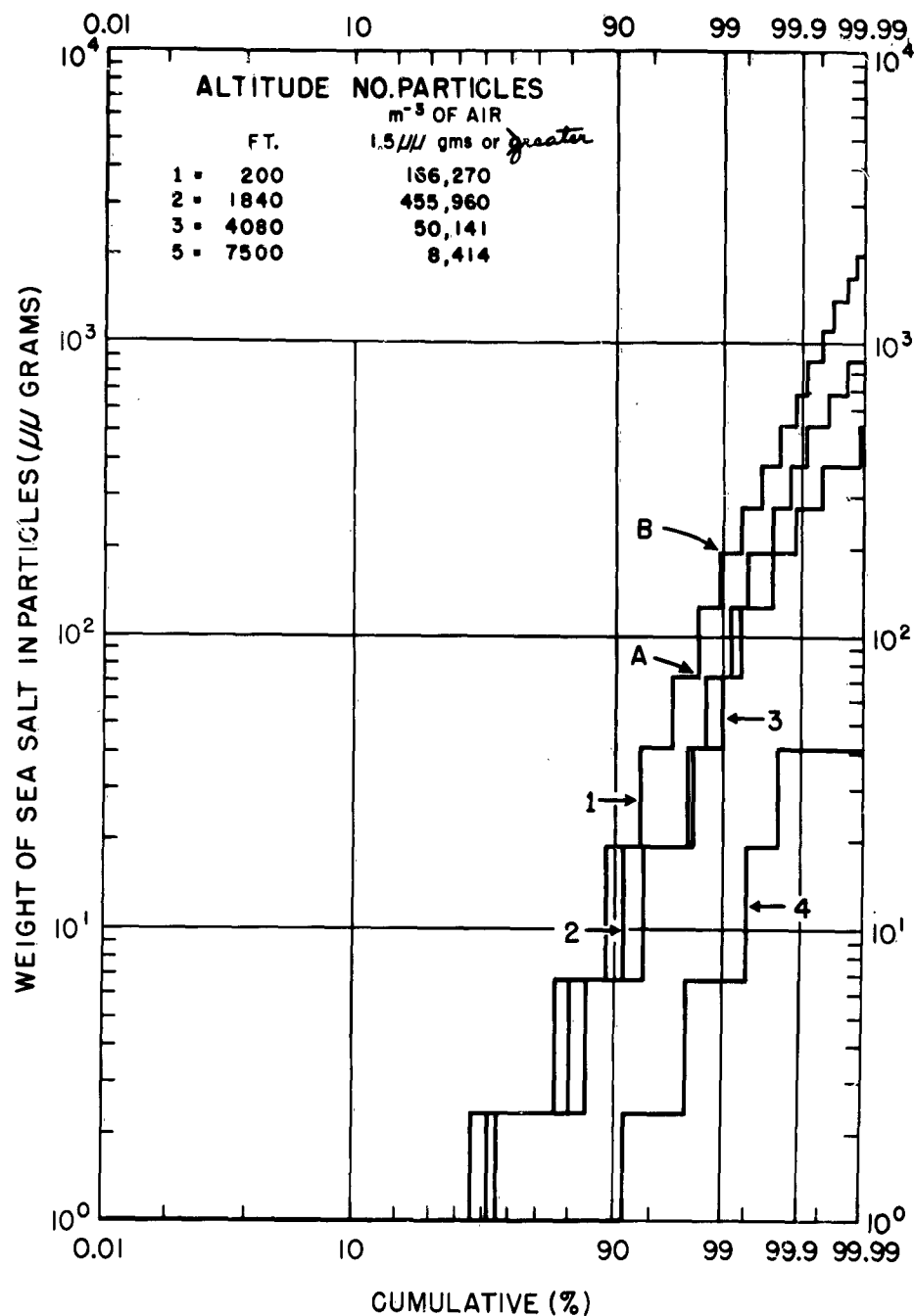
FIGURE 1

Distribution of number of sea-salt particles on
June 4th from near the sea surface to the inversion layer
over the sea on the windward side of the island of Oahu, T.H.
The stepped lines are interpreted as follows: the number of
particles m^{-3} of air at 200 feet in the weight range of 72 $\mu\mu$
grams (point A) to 189 $\mu\mu$ grams (point B) is 98.9% - 98.2%,
or .7% of the total number of particles measured throughout
the range of size measured (see legend).

the 4080 foot level was within the cloud layer and the
lower two levels were in the subcloud layer. This figure
indicates again the decrease in nuclei number in the cloud
layer (see also W.H.O.I. Technical Report No. 51-71) and a
very large decrease above the inversion.

On Figures 2, 3 and 4 a series of rainfall maps
of Oahu are given, representing the days when airborne salt
samples were taken. They are divided into three groups of
days in which gentle-to-moderate, fresh and strong winds
respectively are indicated at the 3000 foot level. Within
these groups the maps are arranged in the order of de-
creasing numbers of salt particles weighing 380 $\mu\mu$ grams
or more. These numbers were taken from cmumlative number
distributions plots similar to Figure 1.

There appears to be a general relationship be-
tween higher salt content and increased rainfall on the
island. The rain sampling method (standard rain gages)
averages the rainfall for a 24 hour period, while the salt
particle sampling period was of only about 30 minutes dura-
tion. Hence fluctuations of the salt content of the air
during the day may reasonably be expected to cause apparent
discrepancies when comparisons are made with the daily
average rainfall. In future studies we hope to avoid this
difficulty by sampling airborne salt several times a day.

It is not intended to imply here that variation
in the number and size of salt particles is the only factor
considered in relation to rainfall. There are, of course,
many other factors involved in rain forecasting[2]. The
relative importance of airborne salt, as compared to other
factors, is yet to be determined.

The physical basis for the grouping of the rain-
fall maps by wind speed at 3000 feet is as follows. Growth
of the larger salt particles to raindrop size is assumed to
occur primarily by an accretion process. It has been shown
theoretically that time or the length of life of the cloud
is an important factor in this growth process (Langmuir,
1948). The length of life of cumulus clouds which result
from air being forced up in flowing over the island, depends
upon the speed at which the cloud is moving relative to the
island. This is due to the fact that the clouds tend to
dissipate after leaving the mountain areas. Thus during
strong winds there is less time for droplet growth within
these clouds and during light winds there is more time.
Therefore, in relating airborne salt to rainfall, it is

(2) See "Physical Basis for Production of Rain in Hawaii".
U. S. Weather Bureau, Honolulu, T. H. 1950.

DATE (1961)	RAINFALL AMOUNT (INCHES)	SALT PARTICLES M^{-3} NO. OF PARTICLES > 380 μμ GRAMS	WIND VELOCITY AT 3000 FEET (KNOTS)	HEIGHT OF INVERSION PRESSURE AT BASE OF INVERSION (Mb)	PRECIPITABLE MOISTURE FROM CLOUD BASE TO INVERSION
JUNE 14		1030 LST 1200	1100 LST 12	0500 LST 1700 LST 840 830	0.730
JUNE 8		1400 LST 384	9	790 780	1.034
JUNE 4		1300 LST 372	9	770 790	1.075
JUNE 10		1130 LST 325	8	860 820	0.848
JUNE 18		1400 LST 68	8	830 860	0.871

Legend:
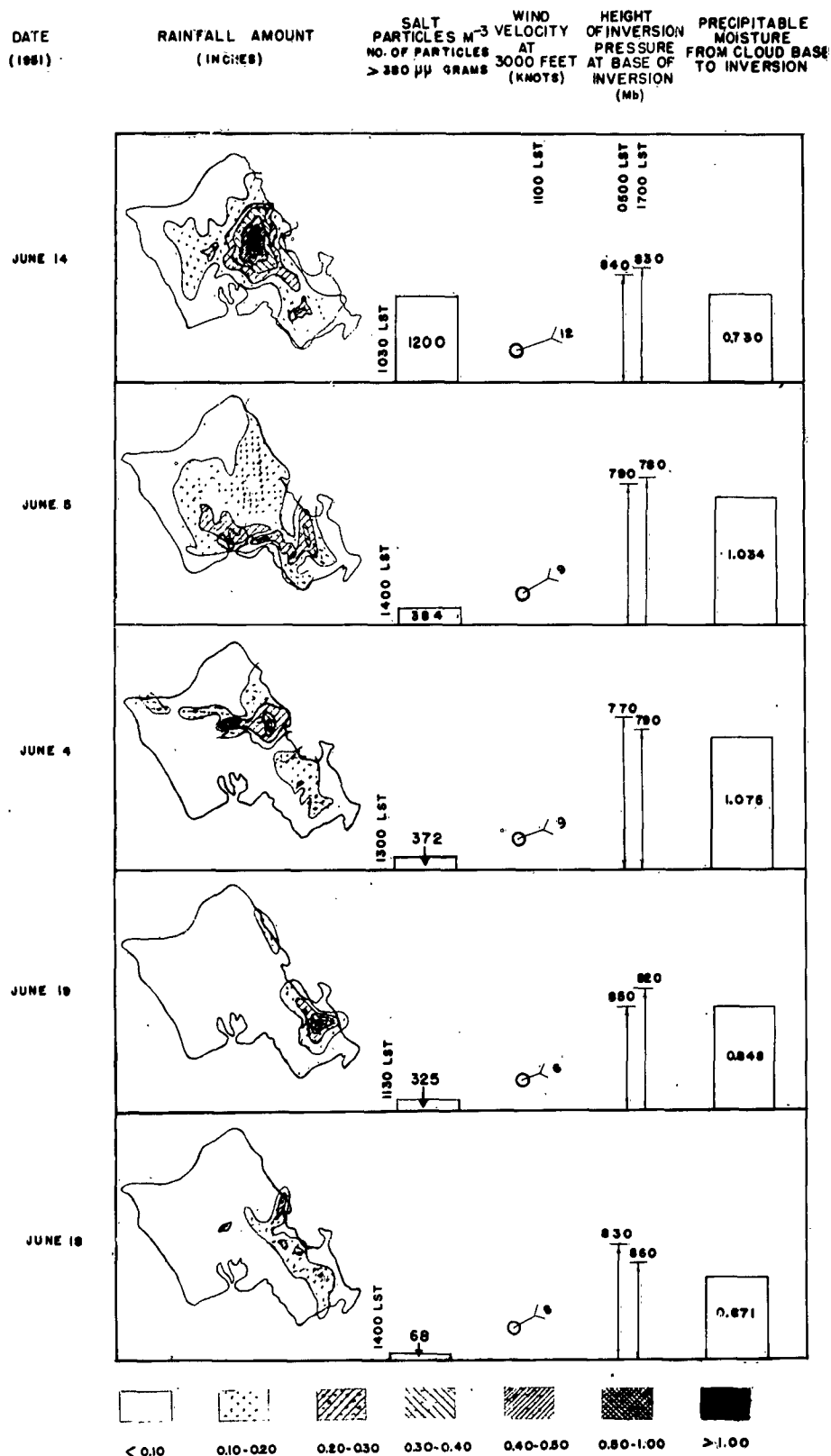< 0.10   0.10-0.20   0.20-0.30   0.30-0.40   0.40-0.50   0.50-1.00   >1.00

Fig. 2

Rainfall maps of the island of Oahu during gentle-
to-moderate winds, arranged in the order of decreasing
numbers of salt particles in the air at cloud levels.

| DATE (1951) | RAINFALL AMOUNT (INCHES) | SALT PARTICLES M⁻³ NO. OF PARTICLES > 380 μμ GRAMS | WIND VELOCITY AT 3000 FEET (KNOTS) | HEIGHT OF INVERSION PRESSURE AT BASE OF INVERSION (Mb) | PRECIPITABLE MOISTURE FROM CLOUD BASE TO INVERSION |

Column headers (as printed):

DATE (1951)   RAINFALL AMOUNT (INCHES)   SALT PARTICLES M^{-3} NO. OF PARTICLES > 380 μμ GRAMS   WIND VELOCITY AT 3000 FEET (KNOTS)   HEIGHT OF INVERSION PRESSURE AT BASE OF INVERSION (Mb)   PRECIPITABLE MOISTURE FROM CLOUD BASE TO INVERSION

JUNE 15 — 1100 LST — 0500 LST — 1700 LST — 800 — 840 — 1500 LST — 2550 — 16 — 0.797

JUNE 13 — 800 — 820 — 1300 LST — 2020 — 16 — 0.933

JUNE 17 — 840 — 870 — 1100 LST — 720 — 17 — 0.626

Legend: < 0.10   0.10-020   0.20-030   0.30-0.40   0.40-0.50   0.50-1.00   >1.00
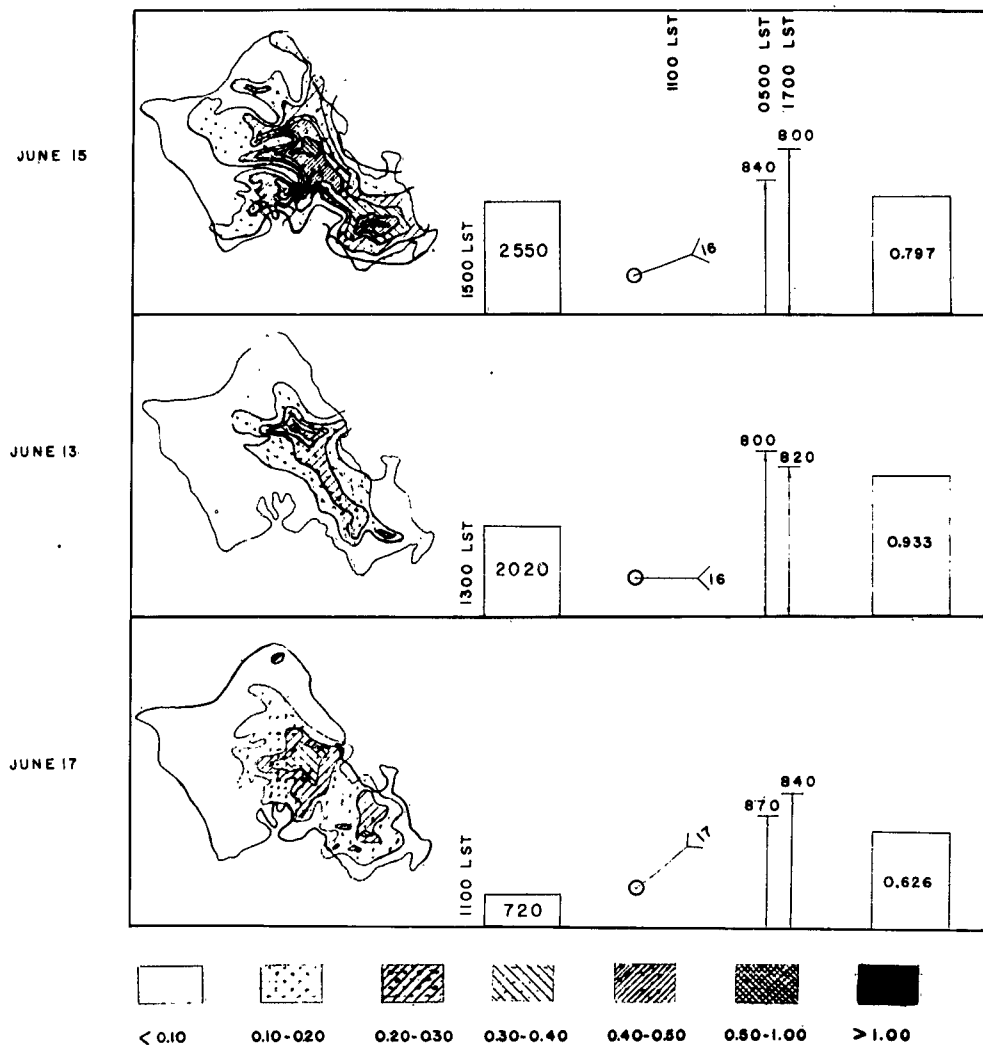
Fig. 3

Rainfall maps of the island of Oahu during fresh winds arranged in the order of decreasing numbers of salt particles in the air at cloud levels.

| DATE (1961) | RAINFALL AMOUNT (INCHES) | SALT PARTICLES M⁻³ NO. OF PARTICLES > 380 μμ GRAMS | WIND VELOCITY AT 3000 FEET (KNOTS) | HEIGHT OF INVERSION PRESSURE AT BASE OF INVERSION (Mb) | PRECIPITABLE MOISTURE FROM CLOUD BASE TO INVERSION |

| DATE (1961) | RAINFALL AMOUNT (INCHES) | SALT PARTICLES M^{-3} NO. OF PARTICLES $> 380\,\mu\mu$ GRAMS | WIND VELOCITY AT 3000 FEET (KNOTS) | HEIGHT OF INVERSION PRESSURE AT BASE OF INVERSION (Mb) | PRECIPITABLE MOISTURE FROM CLOUD BASE TO INVERSION |

JUNE II

1100 LST   0800 LST   1700 LST
770   810
1430 LST   2900
25
1.063

JUNE 16

840
890
27
1030 LST   1506
0.508

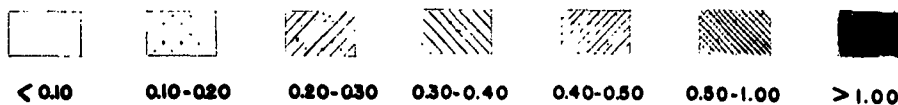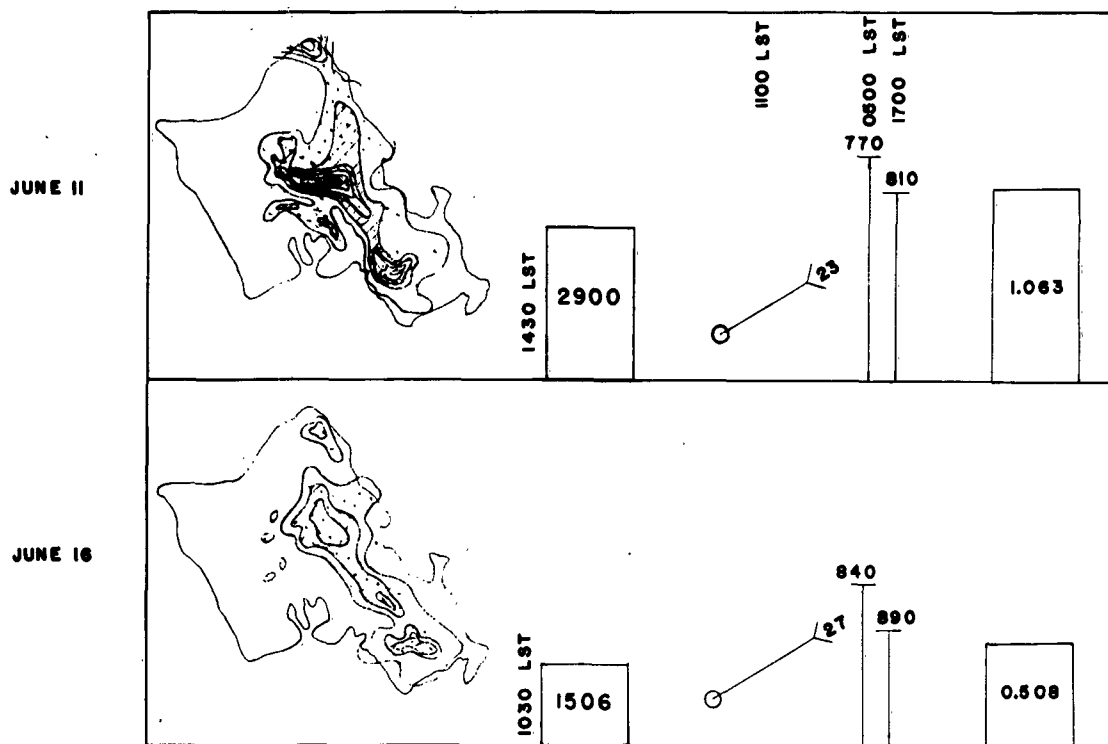< 0.10   0.10-0.20   0.20-0.30   0.30-0.40   0.40-0.50   0.50-1.00   > 1.00

Fig. 4

Rainfall maps of the island of Oahu during strong
winds, arranged in the order of decreasing numbers
of salt particles in the air at cloud levels.

WEIGHT OF SEA SALT IN PARTICLES ($\mu\mu$ GRAMS)

| | 0.01 | 10 | 90 | 99 | 99.9 99.99 |

DATE	ALTITUDE	SALT IN AIR
JUNE	FT.	$\mu\mu$ gms m^{-3}
1 = 4	1840	3.92×10^{6}
2 = 11	1740	14.6×10^{6}

10^4 10^3 10^2 10^1 10^0

2→   ←1

B

A
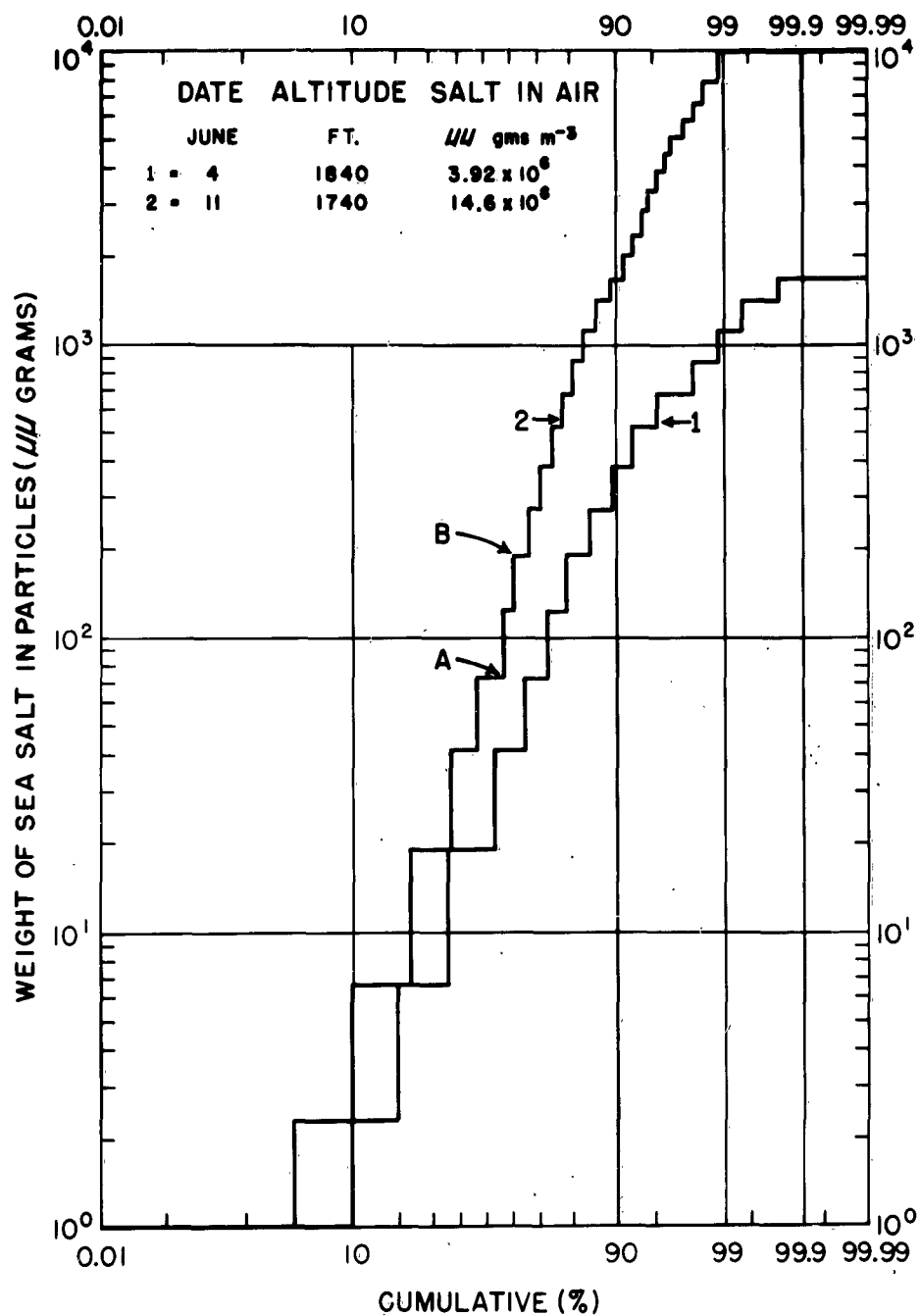
CUMULATIVE (%)

0.01   10   90   99   99.9 99.99

FIGURE 5

Distribution of sea salt particles (by weight)
in the atmosphere near cloud levels on the windward side
of the island of Oahu, T.H. The stepped lines are inter-
preted as follows: the weight of salt m^{-3} of air in the
particle weight range of 72$\mu\mu$ grams (point A) to 189$\mu\mu$
grams (point B) is 61.5 - 57.5%, or 4% of the total weight
of salt measured throughout the whole range of size (see legend).

reasonable to reduce this time factor by comparing those days only on which the winds were more nearly equal.

Cumulative per cent distribution of weight is shown on Figure 5 for two days having large differences in the amount of airborne salt. A comparison of the weight distribution plot for June 4th (1800 ft. alt.) and the appropriate number distribution plot on Figure 1 shows that the median values are quite different. The effects of the stronger winds on June 11th in adding more large particles to the atmosphere is very evident on Figure 5.

An extensive study of airborne salt particles and rainfall among the Hawaiian Islands is planned in the near future.

PART II

Precipitation Studies

In order to study the role of atmospheric sea salt in the formation of rain, it has seemed essential to devise means of sampling rain waters in such a manner that intensity, chlorinity and drop size distribution may be rapidly obtained from aircraft or from the ground. Preparations for field measurements of rain have been made and are briefly discussed below.

This phase of the project has dealt with methods for adequately obtaining drop size samples in rain showers. With these samples it is possible to determine not only the drop size distribution but the nearly instantaneous intensity of rainfall. Through experience it has been found that various techniques of drop size sampling have their shortcomings in some range of the raindrop spectrum. As a consequence it has been necessary to resort to more than one sampling technique. Three methods of sampling have been investigated and will be briefly discussed.

Some work has been done on methods of obtaining bulk water samples for chloride analysis. These methods incorporate sampling both from the ground and from aircraft.

A. Drop Size Distribution Techniques

1. The Flour-Pellet Techniques

The flour pellet method of drop size determination

is based on the fact that water drops falling at terminal velocity will imbed themselves, without splashing, in a layer of sifted flour. Almost immediately after impact flour is absorbed by the water drop, transforming it to a soft dough pellet which, after drying, becomes hard and subject to rough handling without damage. Blanchard (1) has found that the mass of these dried pellets is a linear function of the mass of the original drop. It is then quite simple, by sieving, to segregate the pellets in any given sample into several weight classes and, from the calibration curve, obtain the median drop size for that particular size range. With the median drop size within each size grouping and the corresponding number of pellets one may compute the contribution to the total rainfall by each of the size ranges.

As the pellet weight depends on the amount of water it contains, one might expect a change in weight with relative humidity. This effect was found but it appears to be negligible. For example, pellets which had been weighed before, during, and twenty hours after two days in a desiccator had original drop diameters of 4.7, 4.5, and 4.6 mm., respectively as indicated by the calibration curve. Thus a variation of about 2.2 per cent from the mean is indicated.

The pellet technique, although easy and straightforward to use, has its shortcoming in that it is impossible to detect small fluctuations in the drop size distribution curve for large drops. For large drops the size ranges obtained by standard sieves may be 0.5 mm to 1 mm. It is quite possible that a maximum or minimum in the distribution curve may exist in this range. If so, it would most likely go unnoticed. Because of this shortcoming further work on the pellet technique was suspended.

2. The Nylon Screen Technique

Nylon screens (60 gauge) coated with powdered sugar provide an extremely effective method of obtaining drop size measurements (2). These screens have been snugly stretched over 7 inch diameter metal hoops. A thin layer of lanolin is applied to the nylon fibers by dipping the mounted screens into a lanolin-benzin bath. This layer is necessary as it provides a base to which the sugar adheres.

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(1) Blanchard, D. C. 1949. The Distribution of Raindrops in Natural Rain. Proj. Cirrus Occasional Report, #15, General Electric Research Laboratory, Schenectady, N. Y.
(2) Howell, W. E., Boucher, R. J., and Braun, S. 1951. Experimental and Statistical Studies of the Drop-Size Distribution in Rain, and of the Equivalent Drop-Size Distribution in Snow. Quarterly Progress Report, Mt. Washington Observatory, January 23.

The screens are thus prepared for exposure to the rain. Raindrops, in falling through the screen, will remove a circular area of sugar whose diameter is essentially a linear function of the drop size.

It is expected that the nylon screen will be used to best advantage during rain showers of high intensity. The absence of splash and the relatively small drop imprint area make the screens a valuable tool for work in high intensity rain. However, the very fact that the drop imprint areas are relatively small limits the use of these screens. In rains of low intensity one will often find that the largest drop size present is one millimeter or less. It becomes very difficult to determine accurate imprint diameters when the drop size approaches the mesh size of the screens. For this reason it is desirable to have a sampling method which will allow more accurate determination of drop sizes below one millimeter diameter. It is in this range that the filter paper technique is at its best.

3. The Filter Paper Technique

The filter paper technique is not new (3). It was originated some sixty years ago and has been used with some success by several investigators since. Fundamentally, the technique consists of exposing to the rain filter papers which have been dusted with a water soluble dye. The rain is absorbed by the paper and quickly forms a permanent dyed circular pattern. The diameters of these spots are found, by laboratory calibration, to bear a power curve relationship to the raindrop diameters. Theory predicts that a 1.5 power relationship should exist between drop and spot diameter. The calibration curve recently obtained indicates a 1.33 power relationship. A scale has been constructed from the calibration curve to enable one to read drop sizes in intervals of 0.2 mm directly from the filter papers.

Several different filter papers were tried. It was found that in all cases the spots produced were not circular but elliptical with varying degrees of eccentricity from paper to paper. The criterion for selecting the best paper was the ratio of the major to minor axis of the spots. Whatman #1 filter paper was thus selected, with the lowest ratio, 1.1. The calibration curve for the Whatman #1 paper was made by using the minor axis of the

(3) Wiesner, J. 1895. Bieträge zur Kenntniss des tropischen Regens, SitzBer., k. Akad. Wiss., Wien, Math. naturw. Klasse, 104, 1397-1434.

spots as a measure of the particular drop size. For purpose of calibration of the papers it was necessary to produces droplets of 1 millimeter diameter. This is quite difficult if one uses fine capillary tubes. Following the example of the Harvard group (2) droplets of various sizes were produced by allowing water, with a head of about 2 meters, to emerge horizontally from a fine capillary tube. The drop "spectrum" thus formed is a monotonic distribution of droplets whose size at any point remains fairly constant. The size of these droplets was obtained by allowing them to fall into a shallow glass reservoir containing about a 4 mm depth of Castor Oil. The droplets remain suspended in the oil by a small tangential contact area at the oil surface. With the aid of a microscope light and a hand lens the drop diameter could be obtained by noting the size of the shadow cast on a millimeter scale (with 500 micron divisions) mounted beneath the glass reservoir.

Several filter papers were placed in closed chambers over sulfuric acid-water solutions of varying concentrations. At equilibrium, relative humidities from 5 to 100 per cent were obtained. The spots produced on these papers by drops of known size indicated that the effect of relative humidity is not pronounced over the range from 20 to 80 per cent.

B. Drop Size Distribution From Aircraft

The nylon screen technique has been modified for sampling from aircraft. A device has been constructed which will keep a nylon screen protected from the airstream until the proper moment of exposure. This mounting is so constructed that it will travel by pulley arrangement along a single metal track from the fuselage to a wing strut. When in position a piano wire, actuated from inside the plane, opens a shutter exposing the nylon screen. A spring attachment insures rapid closing of the shutter at termination of the exposure time. After exposure the mounting may be drawn back into the cabin where the exposed screen is removed and an unexposed screen can be inserted, in a matter of seconds. A trial run has been made from an automobile moving through rain at approximately 50 mph. Exposures of about 1 second have given results which seem satisfactory. The mounting, with shutter open and screen in position, is shown in Figure 1.

The calibration of the nylon screens which are to be used from aircraft has been done by allowing drops of known size to fall into the path of a screen which has been mounted on the end of a rotating arm. The instantaneous linear velocity of the screen was adjusted to be 50 mph. The resultant calibration curve indicated that little deformation was occurring upon the drop-screen impact. The
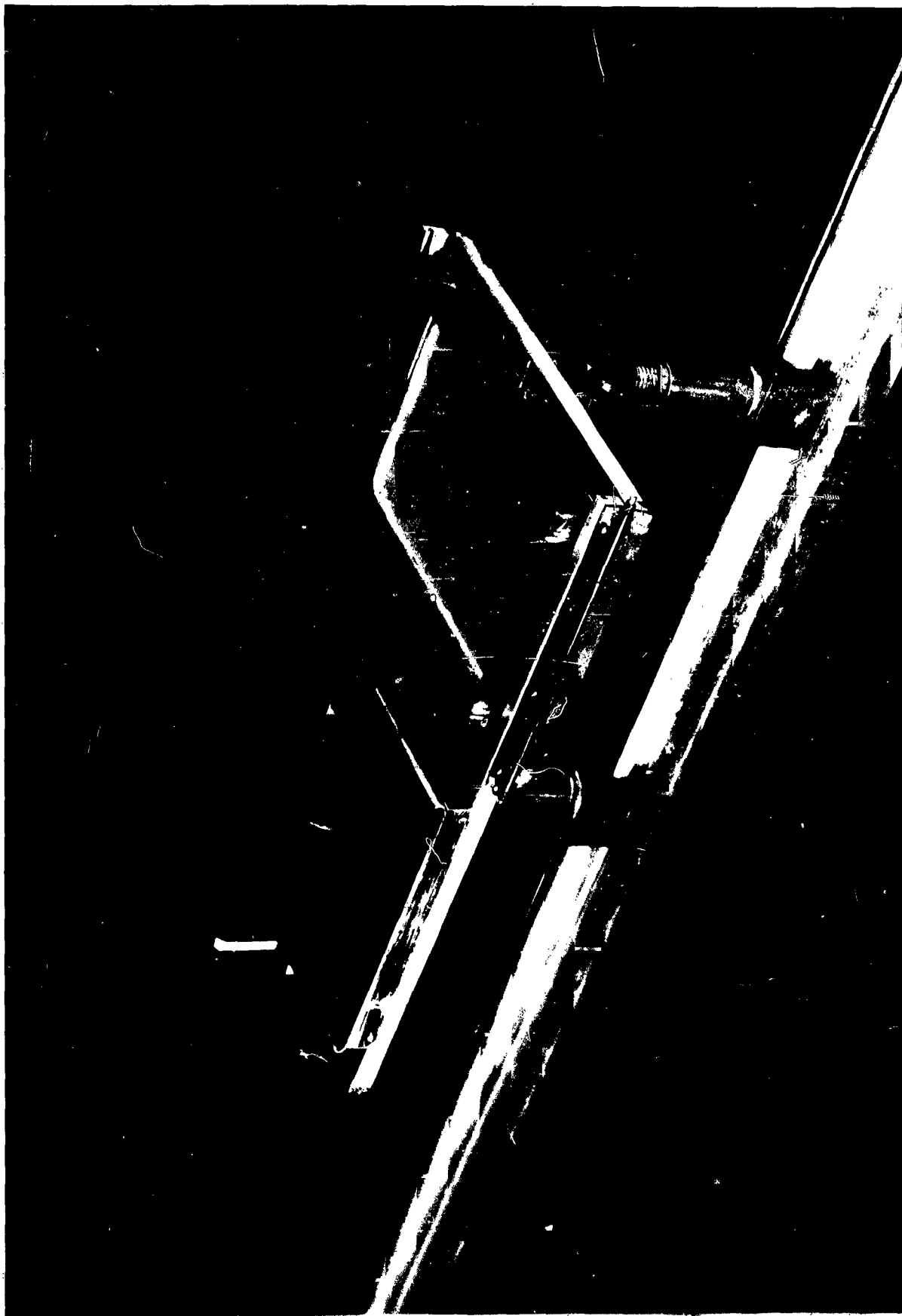
size of the spot, X, was found to be a linear function of the drop size, Y, expressible by the relation $Y = 7/8X$.

C. Bulk Water Rain Samples

1. Collection from the Ground

During a storm the intensity of rainfall will often change several times over a period of several minutes. Therefore, in order to obtain data to relate intensity of rainfall to the chlorinity of the rain water it is necessary to obtain the required amount of rainwater (generally 100 ml.) in as short a time as possible. This has been done by collecting the rain in a large funnel (approx. 80 cm. diameter). In a rainfall of high intensity sufficient water can be collected in 10 seconds or less. The rate of rainfall, I (mm. hr^{-1}), for the particular funnel in use at the present time can be expressed in terms of the exposure time, T, and the amount of water collected, S (cc), as $I = 7.22 \, S/T$. About 35 samples of rainfall have been analyzed for chloride content. In general, it can only be said that a hyperbolic relationship exists between intensity and chlorinity. It is expected that this inverse relationship will be quite striking in the case of rain showers from individual tropical cumulus. It is possible that a family of hyperbolas will be obtained.

2. Collection from Aircraft

It was thought that it may be possible to fasten a deflecting vane on top of the wing which would serve to channel the water picked up by the leading edge into a tube leading into the fuselage. Several types of models were tried in a small wind tunnel. It was found that the water could not be forced to enter a tube in sufficient quantity unless a suction was applied. This in itself would make the method unfeasible as it is difficult on small aircraft to provide the high capacity vacuum which would be necessary.

Woodcock has suggested using the highly absorbing property of cotton cloth as a method of collecting water. When saturated, a single cloth can hold over 100 ml. of water. By experiment in a wind tunnel it was found that such a cloth wrapped around a support will absorb nearly all the water in the volume swept out by the cloth. If the cloth, in actual practice, were wrapped around a rod of 4 cm. diameter and 42 cm. length it would absorb nearly 34 grams of water along a path of 1000 meters assuming a liquid water content of 2 g m^{-3}. A run of 2000 meters would provide sufficient water for chlorinity determinations.

A third method would simply involve mounting two 7" diameter scoops outside the plane. In 1000 meters of

path approximately 100 g. of water would be obtained
assuming as above, a liquid water content of 2 g m^{-3}. In
the case of the scoops one much consider the salt picked up
from the air alone. It was found that, on the basis of
Woodcock's atmospheric sea-salt distribution, less than
one tenth of the amount of salt needed to give a chlorinity
of 2 mg l^{-1} will be picked up in approximately an hour.
This, admittedly, is a rough estimate, but it probably is
high rather than low. Although sufficient salt may be
picked up by the scoops during a long run the large part
would be removed by the water as it first strikes the
scoop. Consequently, the water first collected may show
abnormally high chlorinities for this reason alone.

In the near future it is intended to make some
calculations on the amount of atmospheric salt that is
picked up by the rain (4). If one assumes an initial
concentration of atmospheric salt in the air and no means
of replenishing this concentration, theory will show that,
during a rain shower, the number of salt particles m^{-3}
decreases exponentially. However, the exponential decay
rate will depend on the collection efficiencies of the
raindrops for the salt particles which, in turn, depends
on the relative humidity of the air (a factor which con-
trols the growth of the hygroscopic salt particles). It
is hoped that the collection efficiencies can be worked
out for several values of relative humidity.

PART III

Laboratory Studies in Connection
with Airborne Salt Particles

During the third quarter of 1951 preparations
have been made for the laboratory study of airborne salt
particles. These consisted of the construction of a new
equal pressure weighing chamber and preliminary measure-
ments of growth rates of large airborne salt particles.
Studies of the vapor pressures of concentrated sea salt

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(4) Miyake, Y. and Y. Sugiura, 1950. The Mechanism of
Dissolution of the Atmospheric Chloride into Rain Water.
Papers in Meteorology and Geophysics 1, 222-226.

solutions at temperatures between -20 C and 25 C have also been undertaken.

1. The New Chamber

The basic instrument for the determination of the size and weight of airborne salt particles is the equal pressure weighing chamber, which was described by Woodcock and Gifford (1). For the laboratory studies contemplated, another instrument was found necessary. Although the principle is the same, the design of the new chamber has been radically changed to permit more flexibility in operation and reduction in size of the chamber. The new chamber is essentially a copper box, enclosed in a lucite box which can be mounted upon a microscope stage. The inner, or copper box, is approximately 5 x 2 x $\frac{1}{2}$ inches. It has a removable front for the introduction of samples, a track and movable carriage to permit movement of the experimental slides laterally to the microscope frame and a tray for the acid solutions necessary to maintain a known humidity within the box. Furthermore, this tray can be sealed off from the inner chamber while the whole box remains sealed. In addition to these features the bottom of the copper box is equipped with heaters and a sealed-in pane of glass to permit the introduction of light from the microscope condenser. The top contains a movable slide, which closely fits around the microscope objective, this being to allow sealing from external vapor sources and permit the to and fro motion incorporated in the microscope stage. The copper box also has inlet and exit tubes, which when combined with the sealable tray permit rapid changes in the relative humidity of the chamber from one equilibrium value to another. Another feature is a copper tube soldered to the top and back of the box and containing acetone, which serves as a liquid with a high thermal coefficient of expansion to actuate a mercury regulator switch attached to the outer lucite box. The lucite box incorporates the lower pane of glass of the copper box and its top is provided with a rubber balloon seal to the microscope barrel. The net effect is that the copper box provides a sealed atmosphere of known humidity and temperature, while the outer box serves as a shield to prevent temperature fluctuations on the surface of the copper box. At the present time the chamber is undergoing minor modifications in the above design to permit more effective sealing of the inner box.

Another piece of equipment essential to the apparatus is an external regulating device to transmit the

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(1) Woodcock, A. H. and Gifford, M. M., *Jour*. *Mar*. *Res*. 8, 177.

on-and-off action of the mercury regulator switch to the heater coils. A circuit combining transformers and two thyratron tubes serves to amplify the 100 milliampere switch current to the 1-3 ampere heater current. It is hoped that the present sealing difficulties can be overcome and the box utilized for measurements of growth rates and other properties of the experimental salt particles. Preliminary measurements with imperfect sealing indicate growth rates similar to those reported below.

B. Growth Rate Studies

Information about the rate of growth of airborne salt particles is to be desired if the meteorological importance of these particles is to be clearly understood. At the present time laboratory studies of this have been initiated. The apparatus used was a small teflon equal pressure weighing chamber developed by Mr. Woodcock. This apparatus was designed for use under constant temperature conditions, and relies upon an air space of less than one cubic milliliter to permit almost instantaneous attainment of equilibrium conditions in the atmosphere surrounding the droplets. Preliminary data obtained to date indicates that large airborne salt particles grow to equilibrium size in 10 to 24 hours in a roughly exponential manner at a relative humidity of 98%. Data for these measurements will be presented at a later date.

C. Vapor Pressure Measurements

During the quarter an apparatus was constructed and a number of measurements made on bulk solutions of concentrated sea water. The purpose of these measurements is to replace extrapolated portions of the data obtained by Higashi (2), which have been used to obtain particle weights by the equal pressure method. The work has been performed by Mr. C. F. Kientzler, who has prepared the attached figure. This figure presents smoothed curves derived from the original data. The data is plotted with the difference between the solution vapor pressure and that of pure water as ordinate, and the reciprocal of temperature as abscissa. A more complete report on these measurements will be prepared at a later date.
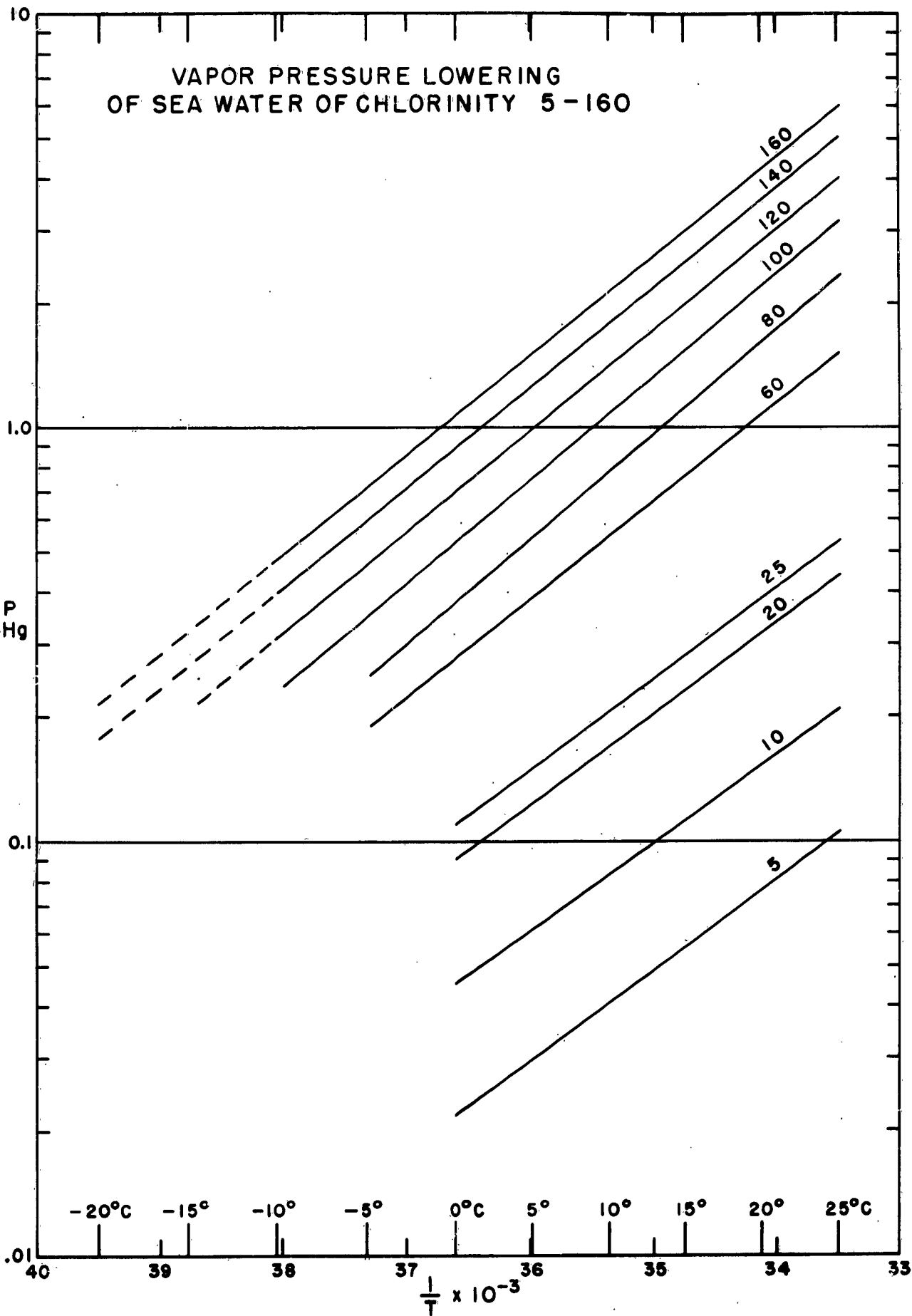
D. Effervescence in Sea Water

As a beginning in the study of the production of

(2) Higasi, K., Nakamura, K. and Hara, R., J. Soc. Chem. Ind. Japan, 34: 166.

VAPOR PRESSURE LOWERING
OF SEA WATER OF CHLORINITY 5-160

- 13 -

aerosols at the sea surface, we have been experimenting recently with effervescing sea water in the laboratory. These preliminary experiments have suggested that the smaller bubbles, rising through the water and bursting at the surface, produce the smaller particles, and that modification of the surface film of the sea water with surface-active materials changes the rate of production of these particles. Only a brief time has been devoted to the very important part of the study of atmospheric salt particles. Later we hope to be able to follow these first observations with a more complete study of effervescence in sea water.